

Auditable Safety Analysis

Auditable Safety Analysis for the MTR Vessel Structure

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TRA Reactor Programs	Auditable Safety Analysis	For Additional Info: http://EDMS	Effective Date: 03/12/03
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ACRONYMS

CFA	Central Facilities Area
CFR	Code of Federal Regulations
D&D	Decontamination and Decommissioning
DOE	Department of Energy
HAD	Hazards Assessment Document
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
MAR	Materials-at-Risk
MCP	Management Control Procedure
MTR	Materials Test Reactor
PLN	Plan
RQs	Reportable Quantities
STD	Standard
TRA	Test Reactor Area

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EXECUTIVE SUMMARY

Since the inactivation of the Materials Test Reactor (MTR), the facility has been categorized as a Category 3 nuclear facility. In the summer of 2002, the facility was reclassified as a low hazard radiological facility.¹ This auditable safety analysis describes the MTR reactor vessel structure, the hazards, and the controls.

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After some 5 years of research and development², in February 1950, the Fluor Corporation Ltd. was appointed construction contractor for the MTR and ground was broken in May. In November of that same year, Phillips Petroleum Company was appointed site-operating contractor. Construction of most phases was completed in February 1952. Criticality was first attained March 31, 1952, using 1,666 g of U-235 in a slab configuration. Design power of 30 MW was attained May 22, 1952.

The reactor was shut down for the last time on August 21, 1970, with a total lifetime operating history of just under 180,000 MW-days. The MTR fuel was immediately removed from the reactor core and transferred underwater to the canal for temporary storage. The fuel was later transported to another INEEL site.

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1.2 Facility Structure

1.2.1 MTR Vessel Structure Area and Buildings

The Test Reactor Area (TRA) MTR vessel structure is defined as the MTR core and reflector structure located in the TRA-603 MTR Building. The TRA MTR vessel structure does not include the remainder of the TRA-603 building. The MTR core and reflector structure is located in the center of the MTR Reactor Building (TRA-603), and consists of a large, 80-ft high, concrete structure (see Figure A-1). High-density concrete, used as biological shielding, encloses the reactor. The shielding structure measures 32 ft 6 in. north to south \times 34 ft east to west, and extends 24 ft vertically above the building's first floor level. Supporting the shielding structure in the reactor building basement is a concrete base enclosing the reactor subpile room. This concrete base is 35 ft north to south \times 36 ft 6 in. east to west. In the basement is also a canal (MTR canal) that extends from beneath the reactor structure eastward about 141 ft. The portion of the canal beneath the reactor has been drained and is isolated by a bulkhead. The MTR canal is addressed in its own safety documentation. Numerous concrete piers below the basement floor support the reactor and canal structures, as well as the building columns; the piers extend down to bedrock.

The top tank of the reactor vessel (the "A" tank) was installed flush with the top of the concrete biological shield. An 18-in. high "A" tank extension was later added (and still remains) on top of the "A" tank. Tanks "B", "C", "D", and "E" are mounted consecutively beneath the "A" tank. The bottom of the "E" tank is located in the subpile room ceiling. The "B" tank is attached to the top of the bottom flange of the "A" tank and serves, by means of a bellows section, as an expansion joint between the "A" and "E" tanks, which are constructed of stainless steel and are permanently fixed in the concrete structure. Tank "B" is constructed of stainless steel, and is located just above the top steel thermal shield plates surrounding the graphite reflector. The "C" tank is fabricated of aluminum and is the upper part of the "ball" zone of the graphite reflector. The "D" tank is constructed of aluminum and surrounds the core lattice and beryllium reflector. The reactor vessel is closed at each end (top and bottom) by lead-filled-stainless-steel-flat-head plugs. The top plug of the reactor vessel has a large viewing port that allowed visual inspection of the inside of the reactor vessel during operation. The viewing port is located in the manhole and now has lead bricks stacked over the top of it to attenuate radiation.

A discharge chute was positioned under a large, removable beryllium reflector piece on the east side of the reactor core. The chute passed through the bottom plug and made the connection to the canal discharge mechanism mounted directly below. Fuel assemblies, control and regulating rods, reflector pieces, and experiment components were passed into the canal by use of this device. The bottom of the reactor bottom plug is accessible from the subpile room.

The elevation of the reactor building first floor is 3.5 ft below the elevation of the reactor core midplane. The reactor core lattice, which contained the fuel assemblies and still contains the beryllium reflector, is located in the "D" tank. A graphite reflector formed the boundary of the usable irradiation space around the reactor core. Thermal shields, made of two 4-in.-thick-steel plates, surrounded the graphite reflector.

Uranium-bearing and, at times, plutonium-bearing fuel assemblies formed the core of the reactor. The core was a 5 \times 9 array of fuel elements, control rods, and experiment-containing pieces. The active core measured approximately 9 in. north to south \times 28 in. east to west \times 24 in. high.

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Surrounding the core was the beryllium reflector which is approximately 39 in. high. It extends to the inner surface of the "D" tank. A large graphite reflector zone surrounds the reactor vessel the "D" tank and extends above and below the "D" tank to cover portions of the "C" and "E" tanks. The graphite reflector measures 12 ft north to south \times 15 ft east to west \times 9 ft 4 in. high. The bottom of the graphite is located 4 ft below the core horizontal centerline.

The graphite reflector was formed by using graphite balls that were 1 in. in diameter in the zone immediately surrounding the tanks. Solid graphite bars were then stacked to form the completed reflector. The ball zone extends the full height of the graphite and measures 7 ft 4 in. \times 7 ft 4 in. The graphite reflector formed the boundary of usable irradiation space around the reactor core. Two discharge chutes are located at the bottom of the ball zone and allowed the dumping of the expended graphite balls into bins. A large volume of cooling air from the reactor building was drawn through the graphite reflector and discharged into the atmosphere through the 250-ft-high-exhaust-gas stack, located 400 ft east of the reactor building.

In addition to the experimental facility liners, other reactor-supporting equipment is embedded into the biological shield. Ducts, which carried air to cool the thermal shields and graphite reflector, run from the four faces of the reactor structure. No credit is taken for this airflow path and the reactor air vents may be found blocked as part of a plan to manipulate the air pressures in the building. Four 24-in. process water lines enter the reactor structure under the basement floor. Two entered the "A" tank and furnished inlet water for cooling the reactor core, and two are connected to the "E" tank and carried the heated water back to the Process Water Building (TRA-605) for degassing and cooling. Structural steel used during construction to support and align the "A" and "E" tanks and other components such as piping, thermal shields, and so forth, is also embedded in the concrete structure.

The thermal column is located on the eastern side of the reactor and is graphite filled with dimensions of 6 \times 8 ft. It extends from the eastern face of the reactor structure to the outside face of the outer thermal shield plate. Six graphite stringers, 4 \times 4 in., penetrate the thermal column to the inner lead window. A second thermal column was planned to be utilized on the west face of the reactor, but it was converted to a facility used for testing shielding materials, and is now filled with barytes concrete blocks.

1.2.2 Neighboring Facilities

TRA is located in the southern portion of the Idaho National Engineering and Environmental Laboratory (INEEL) west of Idaho Nuclear Technology and Engineering Center (INTEC) and north of Central Facilities Area (CFA). TRA is about 100 acres in size. TRA is approximately 10.6 km (6.6 mi) from the northwestern INEEL boundary and houses extensive facilities for studying effects of radiation on materials and fuels.

The Hazard Assessment Document (HAD) -3, "Test Reactor Area (TRA) Hazards Assessment,"³ describes the impact of accidents at various TRA facilities and the necessary actions, which mitigate the consequences of these accidents. The INEEL Plan (PLN) -114-5, "Emergency Preparedness – Addendum 5 Test Reactor Area (TRA)," describes the relationships between these facilities during accident conditions.

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Table 1. List of neighboring facilities.

Facility	Hazard Category
Advanced Test Reactor	Category 1
Nuclear Material Inspection Storage	Category 2
TRA Hot Cells	Category 2
MTR Canal and Plug Storage Holes 1 & 2	Category 2
TRA-635 Radiography Cave	Moderate Radiological
TRA R&D Laboratories	Low Radiological

1.3 Activities

1.3.1 Description of Normal/Daily Activities

1.3.1.1 Operations. Operations within the facility are limited to those required to ensure the integrity of the structure and systems. These include “walk through” surveillance by employees required by institutionalized safety programs.

1.3.1.2 Maintenance. As the facility is in a shutdown condition, minimal maintenance is necessary. There is no scheduled preventative maintenance required for the reactor vessel structure and corrective maintenance is controlled in accordance with institutional safety programs.

1.3.2 Description of Environmental/Compliance Activities

Many of the tanks described in Subsection 1.2.1 have been identified as not meeting environmental regulations. These are managed under a voluntary consent order.⁵

1.3.3 Description of Decontamination and Decommissioning Plans

There are no short term Decontamination and Decommissioning (D&D) plans for the MTR vessel structure.

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Page: 5 of 10**2. HAZARD ANALYSIS****2.1 Methodology of Hazard Analysis**

The radiological and hazardous material source terms were evaluated to determine the categorization of the MTR vessel structure.¹ The evaluation of the facility hazards resulted in a categorization of a low hazard "other than nuclear" facility since it is below a nuclear facility hazard Category 3 based on the unmitigated release of the radiological and hazardous chemical Material-at-Risk (MAR) inventory. This categorization is based on a comparison of the radiological MAR that remains in the facility to the Category 3 threshold quantity values listed in Department of Energy (DOE)-Standard (STD)-1027, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports."⁶ Following the guidance provided in DOE ID O 420.D,⁷ the Category 3 threshold quantities of DOE-STD-1027, were modified for more appropriate release fractions. The MTR vessel structure is a "radiological facility" based on a comparison of the MAR to the Reportable Quantities (RQs) listed in Title 40 of the Code of Federal Regulations (CFR) Part 302,⁸ Appendix B of Table 302.4. As identified in the facility hazard analysis,¹ the hazard classification of the MTR vessel structure is "low."

Subsections 2.1.1 and 2.1.2 describe occupational and unique facility hazards.

2.1.1 Industrial/Occupational Hazards

Since activities involving the MTR vessel structure are minimal, no significant industrial/occupational hazards exist. Activities are limited to monitoring the structure and performing maintenance. Several industrial activities are underway in the MTR reactor building around the MTR vessel structure near the biological shielding. Since these activities do not involve the MTR structure directly, they are covered by separate safety analyses.

The hazard analysis is predicated on the vessel structure remaining in an inactive status. When activities, which could result in the release of hazardous substances, are planned, the facility manager must employ contractor procedures to assure the adequacy of the facility's low radiological classification/categorization and the hazards associated with the new activity.

2.1.2 Unique to Facility/Activity Hazards

No activity hazards unique to the MTR vessel structure exist. As noted in Subsection 2.1.1, activities are limited to monitoring and maintenance required by institutional safety programs.

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3. REQUIREMENTS

Section 2 evaluated the hazards associated with the MTR vessel structure. This evaluation concluded that there are no identified areas of unacceptable risk to workers, the public, or the environment from continued maintenance of the isolation of the source term for the defueled and deactivated MTR under current safety institutional programs. In order to ensure the hazards and mitigation continue to maintain the MTR vessel structure in a safe condition, the following administrative controls are to be maintained.

3.1 Administrative Requirements

Management Control Procedure (MCP) -2451, "Safety Analysis for Other than Nuclear Facilities,"⁹ provides that controls must be maintained to ensure that a facility remains in its approved hazard classification. For a low hazard facility classification such as the MTR vessel structure, controls must ensure that none of the following criteria are exceeded.

3.1.1 Inventory

3.1.1.1 Radiological Inventory. The radiological inventory for the MTR vessel structure is identified in the hazard analysis¹ and the method for computing the inventory is given in Section 3 of Reference 3. Administrative controls must be employed to ensure that if radiological isotopes are added to the vessel structure, the inventory will not exceed that of a radiological facility.

3.1.1.2 Chemical Inventory. If chemicals are added to the structure, a review must be conducted to ensure the added materials are not MAR quantities of hazardous material that meet or exceed Title 29 of the CFR Section 1910.119 threshold quantities or 40 CFR 355 threshold planning quantities (if the hazardous materials are not listed in 29 CFR 1910.119).

3.1.2 Hazards

The identification of hazards for the MTR vessel structure is contained in HAD-207, "Hazard Analysis of the MTR Vessel Structure." Work activities on the vessel structure must be controlled such that the low hazard categorization is not exceeded.

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Page: 7 of 10**4. REFERENCES**

1. HAD-207, "Hazards Assessment Document for the Materials Test Reactor Vessel Structure" [Hazard Classification for Materials Test Reactor Vessel Structure, INEEL/INT-2000-00366, Rev. 1, D. S. Cramer and C. A. Satterwhite]
2. WM-FL-83-016, "Characterization of the Materials Testing Reactor," April 1984
3. HAD-3, "Test Reactor Area (TRA) Hazards Assessment"
4. PLN-114-5, "Emergency Preparedness – Addendum 5 Test Reactor Area (TRA)"
5. Consent Order signed by State of Idaho, Division of Environmental Quality, dated June 19, 2000
6. DOE-STD-1027-92, Change Notice No. 1, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports," U.S. Department of Energy, December 1992
7. DOE ID O 420.D, "Requirements and Guidance for Safety Analysis"
8. 40 CFR 302, "Protection of Environment, Designation, Reportable Quantities, and Notifications"
9. MCP-2451, "Safety Analysis for Other Than Nuclear Facilities."

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5. APPENDIXES

APPENDIX A

Figures

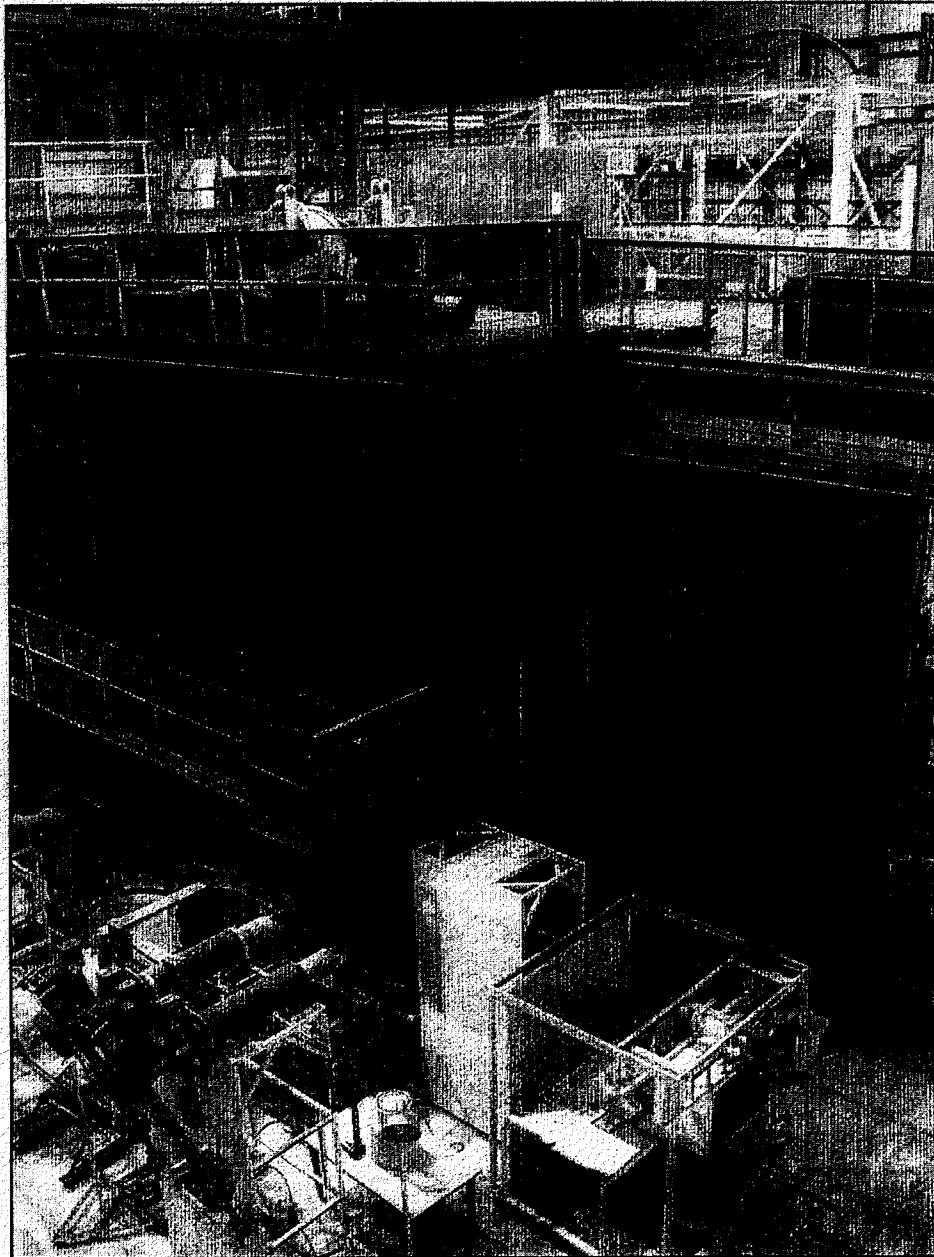


Figure A-1. MTR reactor vessel structure - north side.

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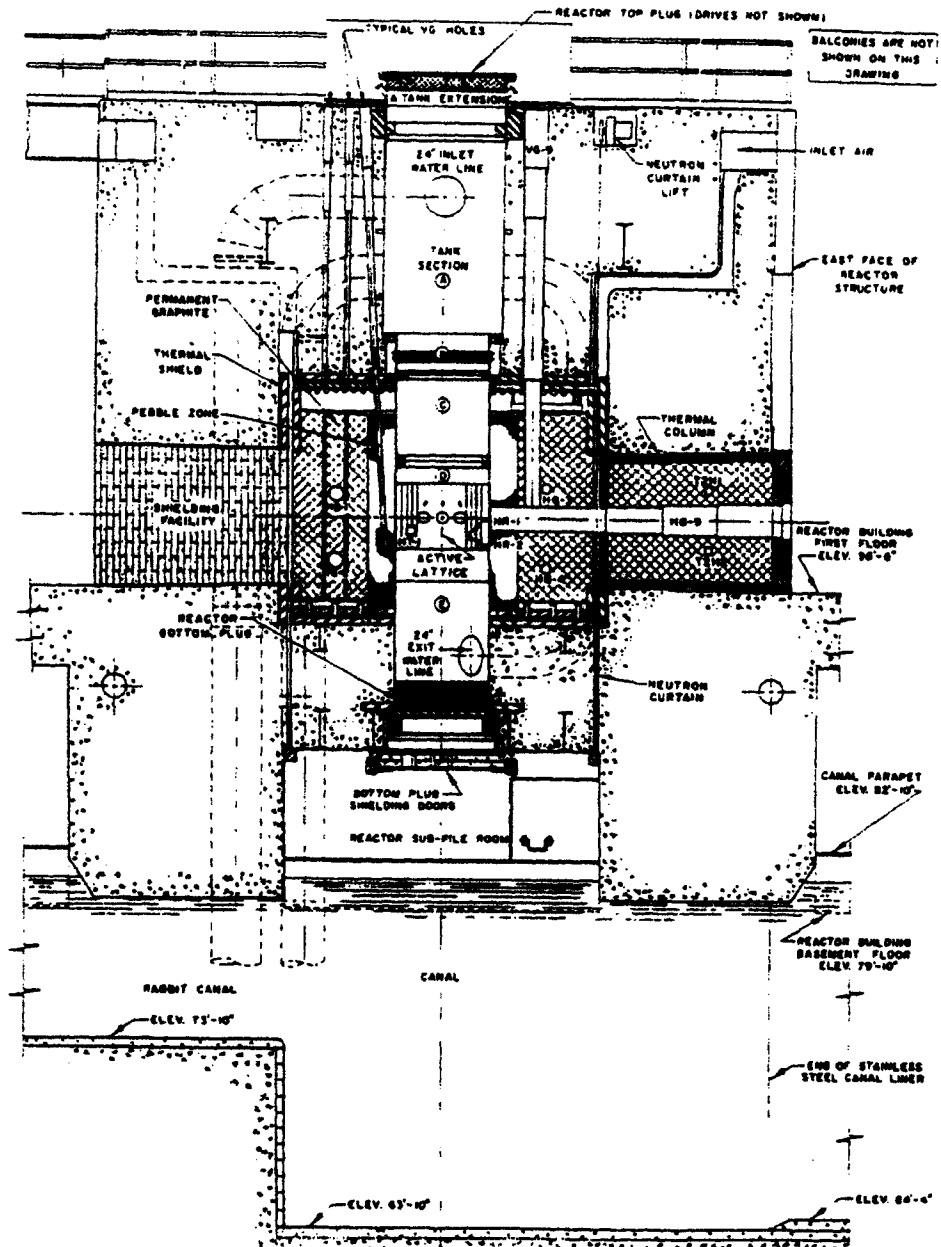


Figure A-2. Cross section of MTR structure as viewed from the south at east-west center plane.

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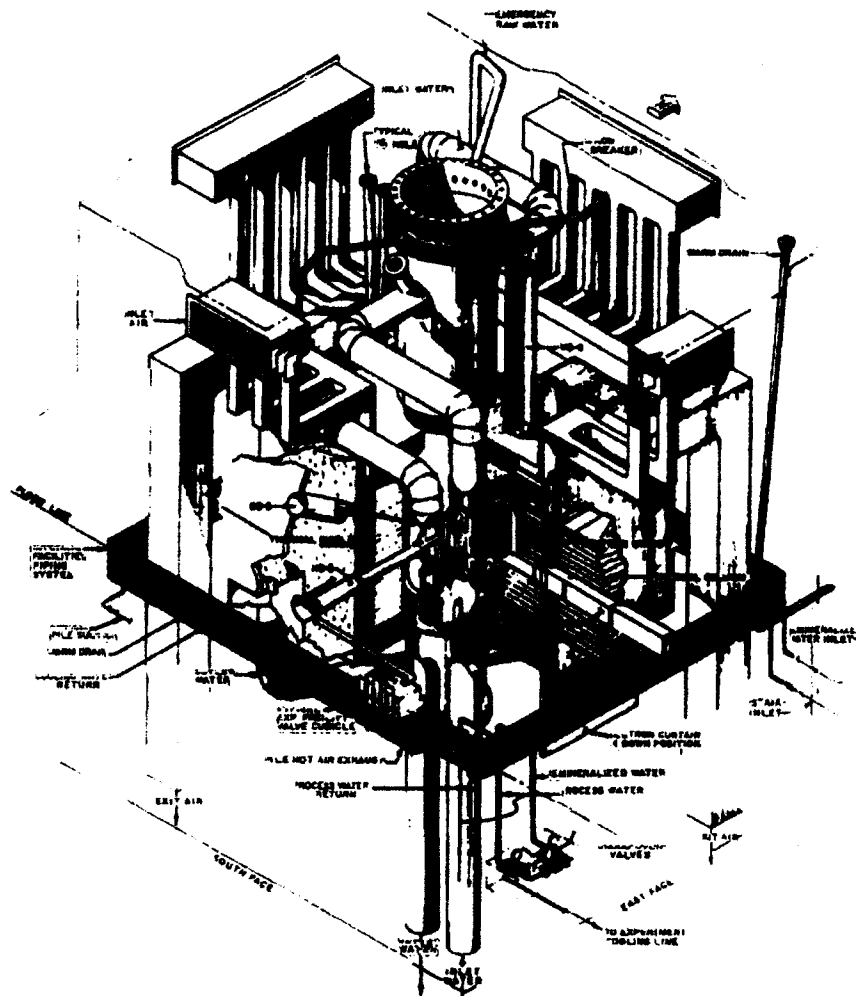


Figure A-3. Isometric view of vessel structure.